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NATIONAL DAM SAFETY PROGRAM. GATEWOOD DAM (VA 15503), PULASKI C--ETC(U)
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Name Of Dam: GATEWOOD DAM

Location: PULASKI COUNTY, VIRGINIA

Inventory Number: VA 15503

LEVEL II

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

(6) National Dam Safety Program. Gatewood Dam (VA-15503), Pulaski County, Virginia. Phase I Inspection Report.

(15) DACW65-78-D-0014

(9) Final rept.

(11) Aug 78

(12) 51 p.

(10) Thomas / Roberts

PREPARED FOR

NORFOLK DISTRICT CORPS OF ENGINEERS
803 FRONT STREET
NORFOLK, VIRGINIA 23510

BY

GILBERT ASSOCIATES, INC.

AUGUST, 1978

154 850

NATIONAL DAM SAFETY PROGRAM
PHASE I INSPECTION REPORT

REVISION NO. 2 TO GATEWOOD DAM

Delete recommendation No. 2 in brief assessment of dam.

Delete paragraph 7.2.2.

REVISION NO. 1 TO PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

GATEWOOD

The cover color is revised to white. The actual cover will not be changed. Each recipient of a copy of this report should notate the existing cover. In addition, add to Section 7, the following paragraphs:

7.1.1 Using the Corps of Engineers screening criteria for initi review of spillway adequacy, it has been determined that the embankment would be overtopped for all storms exceeding approximatel 40% of the PMF. The spillway is therefore, adjudged as seriously inadequate and the dam is assessed as unsafe, non-emergency.

The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to connote the same degre of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard to loss of life downstream from the dam.

7.2.6 In accordance with paragraph 7.1.1, it is recommended that within two months from the date of notification to the Governor of th Commonwealth of Virginia, the owner engage the services of a professional consultant to determine by more sophisticated methods an procedures the adequacy of the spillway. Even though the seriously inadequate spillway would produce a dam failure primarily from hydrologic reasons, remedial measures in structural or geotechnical areas may be needed to remove the dam from an unsafe classification. Within 6 months of the date of notification to the governor, the professional consultant's report of appropriate remedial mitigating measures should have been completed and the owner should have an agreement with the Commonwealth of Virginia to a reasonable time fram in which all remedial measures will be complete. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around-the-clock surveillance should be provided.

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
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(See reverse side)

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

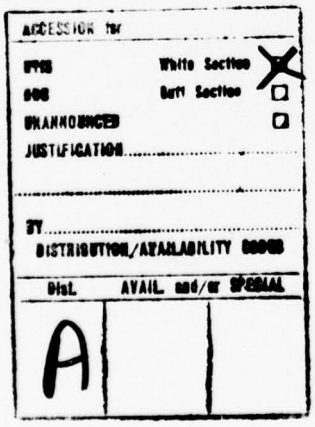
20. Abstract

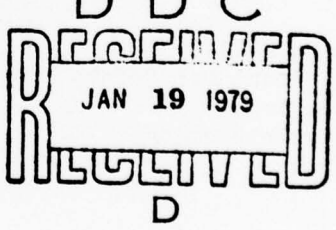
Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam and appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

LEVEL II





PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Gatewood
State:	Virginia
County:	Pulaski
USGS Quadrangle Sheet:	Pulaski, Virginia
Stream:	Peak Creek

The Gatewood Dam is a concrete gravity dam approximately 57 feet high by 408 feet long. The dam has a central overflow spillway and two low level outlets discharging near the left abutment.

The visual inspection of the dam did not indicate that it was in an imminently hazardous condition; however, the inadequacy of the spillway and the lack of information regarding the stability of the dam present concerns about conditions which could become hazardous. See Appendix VI, Conditions.

The spillway capacity was found to be "seriously inadequate" based on the U.S. Corps of Engineers' criteria described in paragraph 5.8, passing only 40 percent of the probable maximum flood (PMF) before the dam would be overtopped. The one-half PMF overtopped the dam by a maximum of 0.9 feet, remaining above the dam for four hours. The PMF overtopped the dam by 4.3 feet.

A stability analysis was not available and a lack of data prevented an independent analysis.

The following recommendations are made for the owner's consideration and implementation:

1. Develop, within 30 days, a detailed emergency warning system to notify the downstream area of any impending danger, and determine those areas subject to inundation from a dam break flood wave.

2. Immediately develop and institute a plan for increasing the spillway capacity of the dam, or take measures to assure that overtopping of the dam will not result in its failure. This work should be completed within 180 days.

3. Evaluate the stability of the dam for the 1 percent design flood, one-half PMF, and PMF. Based on the results of this analysis, the owner should take appropriate action to insure the stability of the dam under all conditions. Particular attention should be given to determining the limits of scour below the dam and its effect on the dam stability. This work should be completed within 120 days after receipt of this Report.

4. Institute a semi-annual inspection program to monitor the conditions of the dam.

5. Maintain a file of all available documents pertinent to the design, construction, and operation of the Gatewood Dam.

Until such time as the above recommendations can be implemented, during periods of heavy rainfall the owner should provide round-the-clock surveillance of the dam and prepare to implement the emergency warning procedures recommended in 1 above.

Prepared By:

APPROVED:

Original signed by:

Douglas L. Haller

Douglas L. Haller
Colonel, Corps of Engineers
District Engineer

Date: 28 AUG 1978

Submitted By: Original signed by JAMES A. WALSH

Recomended By: Original signed by ZANE M. GOODWIN

June 1978

OVERVIEW OF GATEWOOD DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM: Gatewood Dam I.D. #: VA 15509

SECTION 1 - PROJECT INFORMATION

1.1 General

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the U.S. Corps of Engineers to initiate a national program of safety inspections of non-Federal dams throughout the United States. The Norfolk District of the U.S. Corps of Engineers has been assigned the responsibility of the inspection of dams in the Commonwealth of Virginia. Gilbert Associates, Inc. has entered into a contract with the Norfolk District to inspect this dam, Gilbert Work Order 06-7250-001.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (Reference 1 of Appendix V) and contract requirements between Gilbert Associates, Inc. and the Corps of Engineers. The objectives are to expeditiously identify whether this dam apparently poses an immediate threat to human life or property, and to recommend future studies and/or any obvious remedial actions that may be indicated by the inspection.

1.2 Project Description

1.2.1 Dam and Appurtenances: Very little design information was provided for this inspection. What few dimensions are available were obtained during the field inspection, from the dam inventory, or from photographs. A sketch of the layout of the intake gates was provided by the town of Pulaski. Most of the dimensions given in this Report are estimates, and when used in this Report will be identified by an asterisk.

The dam is a concrete gravity dam with a central overflow spillway. The depth of the reservoir is 50 feet and the height of the dam from the base of the spillway to the top of the concrete structure is 57 feet.

A 6-foot* wide deck forms the top of the dam on both sides of the spillway. The total length of the deck on the right abutment is 156 feet*, that of the left abutment 96 feet* and the central spillway section is 156 feet*. The total length of dam at the top is about 408 feet*.

* Approximate dimensions.

Incorporated into the left side of the dam at the end of the top deck and the left edge of the spillway is a wet tower outlet works. The tower is constructed of reinforced concrete and is approximately 14 feet* square. Three sides of the tower are exposed to the reservoir, the fourth side is the dam itself. Four sluice gates are mounted on the three sides of the tower exposed to the reservoir. The gates are set at depths of 10, 22, 34, and 50 feet so that water can be drawn off from selected levels. Three of the gates have 20-inch diameters and the bottom gate has a 36-inch diameter. Water is released downstream through two gated outlets located at the base of the tower. One, a 20-inch steel pipe is the regular service outlet. The other, a rectangular concrete conduit 30 inches wide and 34 inches deep, serves as the main outlet for draining the reservoir. Both outlets run through the dam and discharge at the base near the left abutment. All six gates are controlled from operators located on the top of the tower. None of the gates were operated during the inspection but the mechanisms appeared to be well maintained and water was being released through the service outlet.

The spillway forms the central portion of the dam. It has an ogee crest with a vertical upstream face on the same plane as the upstream face of the dam. Water flows down the face of the dam and then is directed downstream by a slight upward curve at the base. The crest has a central portion about 40 feet wide which is set about 6 inches below the remaining crest level.

1.2.2 Location: The Gatewood Dam is located on Peak Creek about 6.3 miles upstream of the town of Pulaski.

1.2.3 Size Classification: The dam is classified as intermediate in size based upon the height of 57* feet and a storage volume of 3630 acre-feet in accordance with Section 2.1.1 of Reference 1 of Appendix V.

1.2.4 Hazard Classification: The dam is located in a lightly populated area, but is 6.3 miles above the town of Pulaski. A dam failure would cause extensive economic loss and result in the loss of life. Based upon the requirements of Section 2.1.2 of Reference 1 of Appendix V, the dam is classified as a "high" hazard potential. The hazard classification used to categorize dams is a function of location only and is unrelated to the stability or probability of failure.

*Approximate dimension.

1.2.5 Ownership: The dam is owned by the town of Pulaski.

1.2.6 Purpose: The dam and reservoir are part of the water supply system for Pulaski; the reservoir also serves as a recreational area.

1.2.7 Design and Construction History: The dam was designed by Wiley and Wilson of Lynchburg, Virginia, and was constructed in 1958.

1.2.8 Normal Operating Procedure: The water treatment plant for the town of Pulaski obtains raw water from Peak Creek. The reservoir outlet is regulated so that an adequate streamflow is available for the treatment plant and other industrial uses. Inflows exceeding the capacity of the reservoir are passed over the spillway.

1.3 Pertinent Data

1.3.1 Drainage Area: 15.60 square miles.

1.3.2 Discharge at Dam Site: The maximum historic flood at the damsite is unknown. The spillway capacity is presented in more detail in paragraph 5.8.

Spillway Capacity:

Pool level at the top of the dam	10,200 c.f.s.
Pool level with three feet of freeboard	4,310 c.f.s.

Outlet Works:

Maximum Discharge through 20-inch outlet	56 c.f.s.
Maximum Discharge through 36-inch outlet	164 c.f.s.
Combined outlet capacity	209 c.f.s.

1.3.3 Dam and Reservoir Data: Pertinent data is summarized in Table 1.1.

Table 1.1 DAM AND RESERVOIR DATA

Item	Elevation Feet m.s.l.	Reservoir Capacity Area acres	Acre-feet	Watershed inches	Length miles
Top of Dam	2165.2	285	3630	4.36	2.24
Spillway Crest	2158.0	183	1944	2.34	1.86
Streambed at Centerline of Dam	2108±	-	-	-	-

SECTION 2 - ENGINEERING DATA

2.1 Design: The only engineering data provided for the inspection are a sketch of the gate layout in the gate tower, and a previous inspection report by Wiley and Wilson Inc. (Appendix IV).

2.2 Construction: No construction information was provided.

2.3 Operation: No operating records are kept.

2.4 Evaluation: There is insufficient information available on this dam to permit an adequate evaluation. The most significant deficiency is the lack of the basic dimensions of the dam for the purposes of a stability analysis. The spillway capacity can be analyzed based upon the estimated crest width; this will not provide a precise evaluation, but it will show the likelihood of overtopping of the dam during the design flood. There is sufficient information available on the outlet works to provide a reasonable estimate of its hydraulic performance.

SECTION 3.0 - VISUAL INSPECTION

3.1 Findings: The inspection was performed in the afternoon following a period of showers earlier in the day. Although it was not raining during the inspection, concrete surfaces were still wet. At the time of the inspection the reservoir level was about 4 inches below the spillway crest. Sluice gate 1 was open approximately 13 inches and gate 3 was open about 4 inches. Gate 4 which regulates the flow through the 20-inch discharge pipe was open about 4 inches. The discharge flow was estimated at 10 c.f.s. A drawing showing the gate layout for the dam is included in Appendix I.

A previous inspection (Appendix IV) has noted considerable seepage on the face of the dam between monolithic construction joints. Numerous areas on the dam face showed stained concrete surfaces indicating the presence of seepage but no areas were of such magnitude that seepage itself was actually observed. Reportedly during the winter, a 2-inch diameter leak appeared near the northeast end of the spillway. No leaks of this magnitude were observed during the inspection, possibly because thermal expansion of the structure has partially sealed the leak.

Seepage areas were observed on both abutments near the base of the dam. The largest seepage was on the right side and was estimated at 20 g.p.m. with a water temperature of 45°F. A slight odor was noticed and the stones near the effluent point were lightly covered with a tan precipitate. The second seepage area was on the left abutment about halfway up the slope and was estimated at 10 g.p.m. with a water temperature of 55°F. The reservoir temperature was 66°F at the surface and measured 56°F to 58°F at a depth of 28 feet.

There were two areas of the dam structure which showed signs of wear and stress. The top of the third monolith section below the spillway crest, (approximate elevation 2150 feet) on the left side of the dam has developed some severe scaling which is several inches deep. There was no observed seepage from this area, but considerable staining of the concrete below it indicated that seepage may occur under other conditions. A picture of this area is in Appendix II. A transverse crack about 1/2 inch wide on the face of the dam has developed through three of the concrete lifts near the left end of the spillway. The crack occurs at a location where the vertical construction joints of the upper lifts were offset from the joints below

them. The crack starts at a vertical joint, runs diagonally upward across three lifts, and ends at the vertical construction joint of the upper lifts. No seepage was observed from the crack but stains on the concrete indicated that seepage has occurred in the past. The crack is shown in Appendix II.

The pool below the spillway had recently been filled in and showed only slight scouring of the filled-in material. Reportedly, the scour pool was as much as 15 feet deep after the April 1977 storm. (Appendix IV)

3.2 Evaluation: The dam appeared to be functioning well and, with the exception of the transverse crack and deteriorating concrete, the structure looked reasonably sound. At the present low flow rates, none of the observed seepage areas appeared to represent an immediate hazard. The scour hole at the base of the dam could be the source of potential trouble if it has developed to the point of undercutting the toe of the dam. This possibility should be investigated further.

SECTION 4.0 OPERATIONAL PROCEDURES

4.1 Procedures and Maintenance: Maintenance is carried out by the town of Pulaski, but there is no regular maintenance procedure. The operational procedure is simply to maintain adequate streamflows below the dam to meet downstream requirements. No records are kept of the releases.

4.2 Warning System: There is no warning system maintained by the town of Pulaski.

4.3 Evaluation: At present, there are no formal operating and maintenance procedures established for the dam; however, the random spot checks and repairs performed by the town of Pulaski appear adequate. A warning system to notify downstream residents of a potential hazard should be established.

SECTION 5.0 HYDRAULIC/HYDROLOGIC DESIGN

5.1 Design: There was no hydraulic or hydrologic design data provided for the inspection. This data is available from Wiley & Wilson of Lynchburg, Virginia.

5.2 Hydrologic Records: The presence of a corrugated metal standpipe just below the dam indicates that at some time a gaging station was at this location. Presumably this gage was installed at the site during the design stage, prior to construction of the dam.

A stream gage was located at the town of Pulaski but was discontinued in 1957. The gage (#031685000 Peak Creek at Pulaski) was in service from 1951 through 1957. Prior to that, a non-recording gage at the same location was in service from 1927 to 1933.

5.3 Flood Experience: The largest flood of recent history in the Pulaski area resulted from a storm in April 1977 (in some areas of the state, the storm runoff approximated a 100-year flood). There were no data available on the maximum height of the reservoir for this storm. An inspection report (Appendix IV) mentions a deep scour hole at the base of the dam which was probably a result of the flood discharge.

5.4 Flood Potential: The flood potential was evaluated using generalized rainfall information with the flood hydrographs and reservoir routing computed by the HEC-1 computer program. The results of this analysis are presented in paragraph 5.6. These analyses pertain to present hydrologic conditions and do not consider future uncertain conditions, such as urbanization or other changes in the watershed.

5.5 Reservoir Regulation: The reservoir was constructed primarily for the purpose of water supply, but is also used as a recreational area. Whenever streamflows are adequate to provide downstream needs, the reservoir is maintained at or near the spillway crest level. The pool is lowered only when downstream demands exceed the upstream inflows.

5.6 Overtopping Potential: The PMF, one-half of the PMF, and the 100-year flood hydrographs were developed for the drainage basin and routed through the reservoir.

The hydrographs were developed and routed by using the HEC-1 computer program (Reference 2 of Appendix V) and appropriate precipitation, unit hydrograph, and storage volume versus outflow data as input. The triangular unit hydrograph was developed from the drainage area and an estimated time to peak (Reference 3 of Appendix V). Probable maximum precipitation and 100-year precipitation data were obtained from U.S. Weather Bureau publications (References 4 and 5 of Appendix V). Precipitation losses were estimated at an initial loss of 1.0 inch and a constant loss rate of 0.30 inch/hour. Appropriate reduction factors were applied to the PMF in accordance with Corps of Engineers' guidelines. Because of the lack of engineering data on the dam, the spillway capacity had to be estimated based upon dimensions scaled from photographs. Because this method is subject to error, the flood routing was also computed for a spillway 10 feet wider, thus providing an indication of the sensitivity of the findings to the estimated spillway width. The results of this analysis are presented in Table 5.1.

5.7 Reservoir Emptying Potential: The reservoir can be lowered through either the regular service outlet, the bottom outlet, or with both outlets. A volume-elevation curve was not available for the reservoir, so in order to estimate the hydraulic head on the outlet for any given remaining storage volume, the head was assumed to vary as the cube root of the storage volume, being equal to the depth of the normal pool for a full reservoir and equal to zero for an empty reservoir.

The time to empty the reservoir using both outlets or just the 20-inch service outlet was calculated assuming an average inflow to the reservoir of 20.3 c.f.s. (1.3 c.f.s.m.). With both outlets open it will take about eight days to empty the reservoir. If for some reason only the service outlet is in operation it will take about 50 days.

5.8 Evaluation: The screening criteria for assessing the adequacy of the spillway design flood allow essentially no risk of loss of life from dam failure by overtopping. Experience indicates that very few existing non-Federal dams were designed with such conservative criteria. Therefore, the Phase I inspection findings will indicate noncompliance with the spillway design flood screening criteria for most non-Federal dams. In accordance with Corps of Engineers' Engineer Technical Letter (ETL) No. 1110-2-234, a further classification is required based upon the percent of the PMF passed before overtopping occurs and the consequences of the dam being overtopped and failing. Based upon these criteria, the spillway may be further classified as "seriously inadequate."

Table 5.1 - RESERVOIR PERFORMANCE

Item	Flood		
	One Percent (a)	1/2 PMF	PMF (b)
Peak Discharge, c.f.s.:			
Inflow -	5550	15,100	30,100
Outflow -	3980	12,900	27,300
Peak Elevation, feet, m.s.l.	2162.0	2166.1	2169.5
Ungated Spillway:			
Depth of Flow, feet (c)	3.1	6.2	8.8
Average Velocity, f.p.s.	9.2	13.5	16.1
Non-overflow Sections: (estimated width 156 feet)			
Depth of Flow, feet (c)		0.6	2.7
Average Velocity, f.p.s.		4.3	9.3
Duration, hours		4.0	9.0
For a Spillway ten feet wider (d) (estimated width 166 feet)			
Peak Elevation		2165.9	2169.2
Depth of Flow, feet (c)		0.4	2.5
Average Velocity, f.p.s.		3.8	9.0
Duration, hours		4.0	8.0

Notes:

(a) The 1 percent exceedence frequency flood has one chance in 100 of being exceeded in any given year.

(b) The PMF is an estimate of flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

(c) Critical depth.

(d) A 10-foot wider spillway was used in a second calculation to indicate the effect of a possible error in the estimate of the spillway width.

The design flood for the Gatewood Dam is the PMF. The spillway capacity is sufficient to pass approximately 40 percent of the PMF before overtopping the dam. The PMF will flow 4.3 feet over the dam for as long as eight hours and the one-half PMF will overtop it by 0.9 feet for four hours. Based upon ETL No. 1110-2-234 the spillway is considered "seriously inadequate." If the owner can demonstrate that the dam can withstand being overtopped by the depth and duration of the one-half PMF without failing, this classification can be reduced to the "inadequate" classification. A "seriously inadequate" spillway must be corrected immediately.

SECTION 6.0 DAM STABILITY

6.1 Stability Analysis: There was no stability analysis provided for an evaluation and insufficient data on the dam structure and foundation materials for an independent analysis to be made.

Reportedly, the flood runoff of April 1977 left a scour hole at the base of the dam. The scour hole has since been filled with loose rock from the stream bed, but the extent of the scour hole had not been determined. It is possible that the scour hole has undercut the toe of the dam and could affect the structural stability. This possibility should be investigated.

6.2 Foundation and Abutment: The dam is apparently founded on sandstone and siltstone rock with the abutments also keyed into rock. The rock strikes N 70°E with an approximate dip of 30° toward the southeast.

Seepage was occurring at the bottom of the right abutment at about 20 g.p.m. Loose rocks at the seepage area were coated with a residue which was not a calcium precipitate, and the water had an unpleasant odor. The temperature of the seepage water was 45°F. The source of the seepage water was undetermined but sewage from a presently unoccupied house on the top of the abutment may account for the odor and precipitate of the seepage.

Seepage at the left abutment was occurring from approximately mid-height of the dam to the base of the dam. Total seepage was approximately 10 g.p.m. at a water temperature of 55°F. Lake temperature at a depth corresponding to the elevation of seepage was 56°F to 58°F. The lake surface temperature was 66°F. All seepage was clear.

6.3 Evaluation: There are insufficient data to evaluate the stability of the dam. Because stability is a prime factor in the design of a concrete gravity dam, a stability analysis probably was performed during the original design. The analysis should be obtained for review or another analysis performed.

The extent of scouring that was reported to have occurred at the base of the dam after the 1977 flood was not determined. However, the toe of the dam may have been undercut and this possibility should be investigated. The scouring in the streambed had been backfilled with broken rock that was

displaced by the flood waters. A further investigation should include the necessary remedial action with proper sizing of rock fill to minimize scouring in the plunge basin. Seepage does not appear to be serious at this time.

The dam is located within Zone 2 on the Algermissen Seismic Risk Map of the United States (1969 edition) and there are uncertainties with respect to the static stability of the dam, as described in paragraph 6.1. Therefore, in accordance with paragraph 3.6.4 of Reference 1 of Appendix V, assessments should be made regarding seismic stability, based on the studies outlined in paragraph 7.2.3.

SECTION 7.0 DAM ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

The assessment, recommendations, and remedial measures contained in this Report are based on the provisions of Appendix VI, Conditions.

7.1 Dam Assessment: The inspection was severely limited by the lack of design information; however, this limitation was mainly restricted to the stability analysis of the dam. The conclusions reached by the hydrologic studies should be valid even though the spillway width was estimated. It was shown in the study that a 10-foot error would produce only a minor change in the maximum level of the reservoir under PMF and one-half PMF conditions. The flood analysis showed that a one-half PMF would overtop the dam by 0.9 feet, and the PMF would overtop the dam by 4.3 feet. The spillway is "seriously inadequate" based on the U.S. Corps of Engineers' criteria described in paragraph 5.8.

The condition of the concrete in the dam in some areas is cracked and scaling, and many of the joints show signs of leaking; however, none of these conditions are an immediate threat to the stability of the dam. Areas of seepage were identified on both abutments; although the flows were clear and at low rates, they should be monitored to detect any significant increase.

7.2 Recommendations/Remedial Measures:

7.2.1 Warning System: A detailed emergency warning system should be developed as soon as possible to notify the downstream inhabitants of any impending dam failure. For the warning system to be effectively applied, a study of the downstream area should be made so that the areas subject to flooding as a result of a dam break can be identified.

7.2.2 Spillway Capacity: The owner should immediately initiate work toward increasing the capacity of the spillway or take measures to assure that overtopping of the dam will not result in a dam failure. This work should be completed within 180 days after receipt of this Report.

7.2.3 Stability Analysis: The owner should obtain from the designer of the dam documentation of any previous stability analysis of the dam (if such exists) and submit the data to the Virginia State Water Control Board within 30 days after receipt of this Report. If no previous studies have been performed, the owner should enlist the services of a qualified

consultant to perform the analysis. An additional study should be made to determine the magnitude of the scour below the dam and the impact such scour will have on the dam stability. The owner should have this study available in 120 days.

7.2.4 Inspection Program: The owner should establish a semi-annual inspection program to establish a record of conditions at the dam. Such a program should include monitoring seepage areas, condition of concrete, condition of operating equipment, sedimentation in the reservoirs, and scour at the base of the dam.

7.2.5 Design Documents: A complete set of available design documents should be maintained by the owner. These files should include available design drawings, calculations, pertinent correspondence, and maintenance records.

APPENDIX 1

MAPS AND DRAWINGS


JEFFERSON
NATIONAL FOREST
CHESTNUT
Pondlick
Branch
Mt Olivet
Gatewood Reservoir
#1
BRUSHY RIDGE
GATEWOOD
Peak
NOREDEAD
WESTERN
Creek
Creek
Hollow
Hollow
Colonel
Indian
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PULASKI CO
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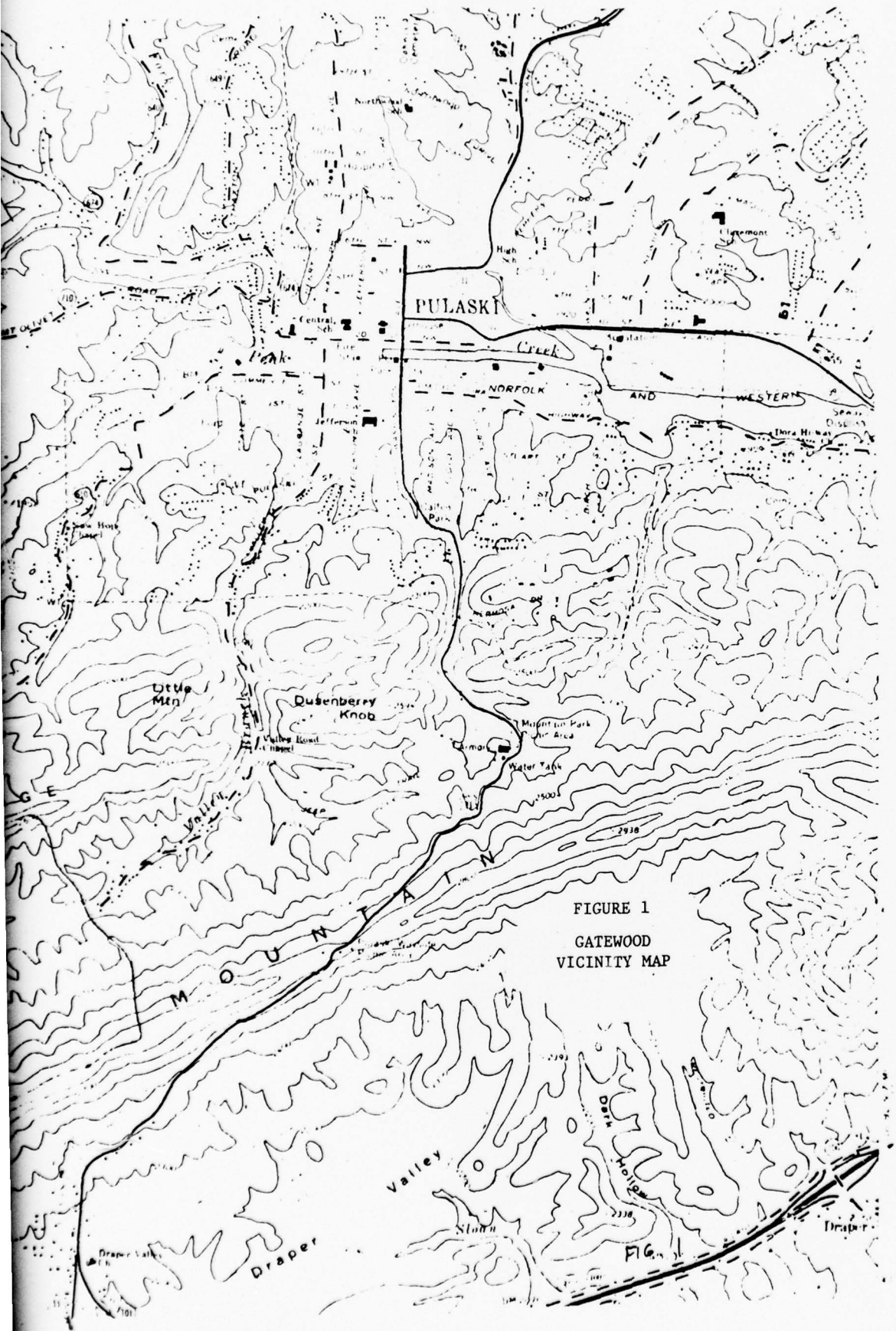
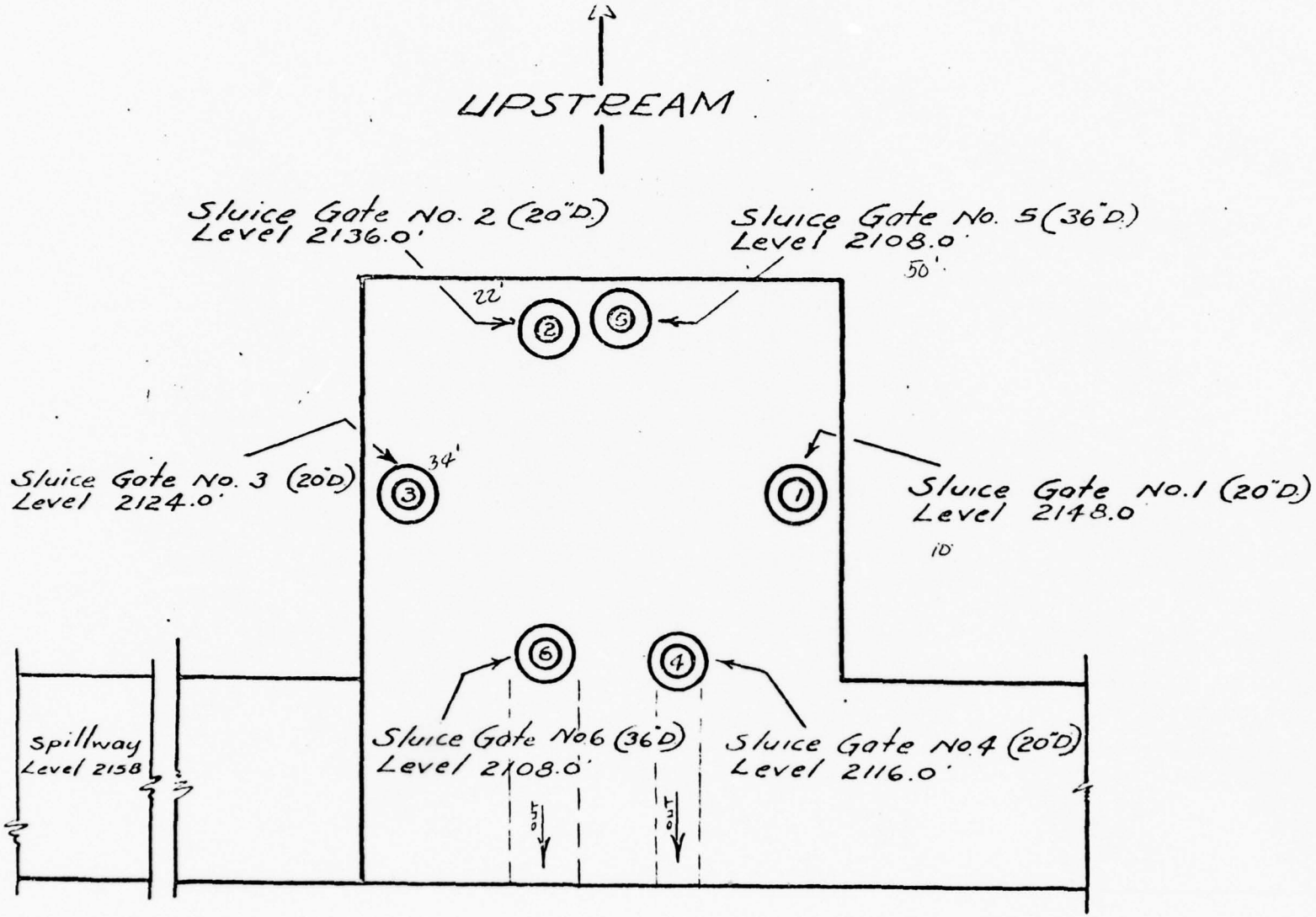


FIGURE 1

GATEWOOD
VICINITY MAP

2



Source: Town of Pulaski

FIGURE 2
GATE DIAGRAM
GATEWOOD DAM

APPENDIX II

PHOTOGRAPHS

June 1978

VIEW OF THE DAM CREST AND GATE TOWER

June 1978

GATE TOWER AND OPERATING DECK

June 1978

VIEW OF SEVERE DETERIORATION OF CONCRETE ON LEFT ABUTMENT

June 1978

TRANSVERSE CRACK ON THE FACE
OF THE DAM

APPENDIX III

FIELD OBSERVATIONS

CHECK LIST
VISUAL INSPECTION
PHASE 1

Dam Name: Gatewood County: Pulaski State: Virginia Coordinators: Norfolk District Corps of Engineers

Date(s) Inspection: June 8, 1978 Weather: Showers Temperature: 70°F±

Pool Elevation at Time of Inspection: 2157.7 feet m.s.l. Tailwater at Time of Inspection: 2108 feet m.s.l.

III-1

Gilbert Associates, Inc.
Inspection Personnel:

Thomas E. Roberts

Thomas W. Schreffler

William J. Santamour

Also Attending:

John Hawley - Town of Pulaski

Ron Coake - Town of Pulaski

Charles Boone - Virginia State Water Control Board

Thomas W. Schreffler - Recorder

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
SEEPAGE OR LEAKAGE		
STRUCTURE TO ABUTMENT/ EMBANKMENT JUNCTIONS	Seepage was observed at the base of the dam on both abutments. On the right abutment it is estimated at 20 g.p.m. It had an odor and was at 45°F. On the left side, the flow was about 10 g.p.m. and was measured at 55°F.	
DRAINS	None observed.	
WATER PASSAGES	Two passages were located near the left abutment. One, a 20-inch steel pipe was flowing about 6 inches deep (estimated at 10.6 c.f.s.). The other was just to the right and lower than the first pipe. It was a rectangular opening 2.5 feet wide by 2.8 feet high. The floor was covered with rocks and gravel and there was no flow.	
FOUNDATION	The dam is apparently founded on sandstone and siltstone, as projected from the abutment rocks.	
SURFACE CRACKS CONCRETE SURFACES	Concrete surface of the valve operator deck has some scaling.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
STRUCTURAL CRACKING	A transverse crack running through three concrete lifts was observed below the left end of the spillway. The crack starts five lifts below the crest at a level where the vertical construction joint between monoliths was offset. It then runs downward and intersects another vertical joint.	
VERTICAL AND HORIZONTAL ALIGNMENT	All concrete surfaces appeared straight or built to the proper contour. No bulging or sagging was observed.	
MONOLITH JOINTS	Efflorescent deposits on face of dam indicates seepage above joints. Because of wet weather conditions, it could not be determined if any seepage was actually coming through the joints. The worst area was near the left side of the dam where deterioration of the concrete is also visible, but signs of seepage are also visible at the base of the dam for the entire length.	
CONSTRUCTION JOINTS	Not applicable.	

OUTLET WORKS

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Not applicable.	
INTAKE STRUCTURE	Intake is part of the dam structure. It appears to be a wet tower at the back of the dam. Six valve operators without hand cranks are on top of the operating deck.	
OUTLET STRUCTURES	Outlet consists of two conduits; one, a 20-inch steel pipe; the other, a concrete channel through the dam. The pipe is flowing 0.5 feet deep and slopes at about 8^{o}.	
OUTLET CHANNEL	Discharge is at base of the dam into the main channel of the stream.	
EMERGENCY GATE	Not applicable.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	No serious flaws observed in the concrete. The center portion of the crest is lower by approximately 6 inches.	
APPROACH CHANNEL	Not applicable.	
DISCHARGE CHANNEL	Channel was gravelly, but did not have any scourpool at the base of the spillway. According to the owner's representative, the pool had been filled in prior to our visit.	See Wiley & Wilson Inspection Report July 21, 1977
BRIDGE AND PIERS	A small footbridge crosses the stream 300 to 400 feet below the dam. It would not restrict downstream flow significantly.	

INSTRUMENTATION

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	An abandoned stream gaging point was just below the dam.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Viewed from dam crest. No sloughing observed.	
SEDIMENTATION	None.	

DOWNSTREAM CHANNEL

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Gravelly stream, was recently filled in. A small footbridge crosses the stream, but would not obstruct the flow.	
SLOPES	Heavily forested slopes.	
APPROXIMATE NO. OF HOMES AND POPULATION	No homes for two miles. Town of Pulaski is 5 miles below dam.	

APPENDIX IV

INSPECTION REPORT

WILEY & WILSON, INC.
A PROFESSIONAL CORPORATION
ENGINEERS · ARCHITECTS · PLANNERS
LYNCHBURG – RICHMOND – VIRGINIA BEACH

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P. O. BOX 877
LYNCHBURG, VA. 24505
804-847-9192

FOUNDERS
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E. J. P. WILSON, PE 1884-1961

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T. R. LEACHMAN, AIA — W. M. GREENWOOD, PE
J. A. BOOTON, PE

CONSULTANT — RETIRED
E. E. BOYNTON, PE — W. E. ROYALL, PE

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C. M. PARKER, PE — KENT EVANS, JR., PE

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R. C. GOOL, JR., PE
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R. P. JEFFRIES, PE — P. R. MAYS, PE
L. D. AUSTIN, PE — R. G. ROBERSON, PE
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S. T. THOMPSON, JR., PE — J. C. PAGE, III, RA
J. L. THOMPSON, PE — R. A. LEMON, PE

July 21, 1977

Mr. J. E. Marshall
Town Manager
Town of Pulaski
Municipal Building
Pulaski, Virginia 24301

Attn: Mr. Ron Coake

Re: Hogan & Gatewood Dam Inspection
W&W Comm. No. 7127

Gentlemen:

This is a report of our inspection of Hogan and Gatewood Dam as authorized in your letter of March 16, 1977.

The purpose of this inspection and report is to identify areas of the dams which have deteriorated and recommend needed repairs. Additionally, we are including an estimate of the cost to repair the defects in the dams.

Both dams were visually inspected June 17, 1977. We inspected and photographed all of both structures which were exposed above the water line and above grade. The upstream face of each dam was inspected at the water line with the use of a boat. Embankments adjacent to both dams were inspected by walking over the area and looking for leaks and seepage.

In addition to the field inspection, we have reviewed the original plans for Hogan and Gatewood Dams as well as the previous inspection report dated September 1970.

Hogan Dam Inspection:

Our observations of Hogan Dam were as follows:

1. Recent Construction - The spillway section has been lowered to its height prior to 1946. The southwest side of the

spillway channel has been walled with a counterforted type retaining wall to retain the water in the spillway channel. This counterforted wall appears to be in as-built condition. There is no evidence of any flood waters exceeding the capacity of the existing spillway channel.

2. Leaks - There is no evidence of significant leaks in this dam or its abutments. The only leak we were able to detect was on the left looking upstream approximately half way up the dam at the intersection of the dam and the abutment. This leak had a flow of approximately 1 to 2 gallons per minute.

3. Erosion - No erosion is in evidence on any part of the dam. Additionally, the spillway streambed appears to contain the overflow adequately with no significant erosion.

4. Deteriorated Concrete - The top of the dam which is exposed to view above the spillway crest shows some deterioration near the upstream water line. The concrete in these areas has been previously patched. Now, the patched areas are beginning to deteriorate and should be replaced. There is no evidence of any leaks through this concrete wall section.

5. Drains - The drain pipe at the base of the dam is discharging a flow that we estimate to be greater than 20 gallons per minute.

6. Valve Operators - The water intake valve operators appear to be in good repair. We did not, however, attempt to operate any of the valves.

7. Water Level - The water level in the dam was up to the crest of the spillway, but without any water flowing over the spillway.

Recommendations:

We recommend that the deteriorated concrete just above the water line on the upstream face of the dam be replaced. The defective material should be replaced with cast-in-place concrete bonded with epoxy. We estimate the cost for replacing the defective concrete to be approximately $6,700.

Gatewood Dam Inspection:

Our observations of the Gatewood Dam were as follows:

1. Water Level - The water level in the dam was approximately 2 feet below the normal spillway crest.

2. Leaks @ Abutments - Two leaks exist in the abutment area of this dam, neither are significant. One leak occurs at the southwest edge of the streambed at the toe of the dam. We estimate that this leak exceeds 10 gallons per minute. From the existing records and from the memory of those in our offices who have previously worked on the dam, it appears that this leak has not increased in volume. At the northeast abutment area there is a small flow of water seeping out of the bedrock at the rate of approximately 2 gallons per minute. This leak is near the intersection of the dam and the bedrock at approximately 10 to 15 feet below the top of the dam.

3. Leaks in Concrete - Several small leaks are coming directly through the concrete dam primarily at construction joints. We were able to count at least five leaks coming through the dam at various elevations which had enough flow in them to reach the tailwater before the flow could evaporate. More than this number of leaks exist elsewhere in the dam which dry up before reaching the tailwater. There is evidence of numerous previous small leaks similar to these that currently exist that have dried up and are only efflorescent stains on the dam. Mr. Leroy Early, Director of Public Works, informed me that during the past winter when the temperatures were down below zero that a leak developed in the dam approximately half way up near the northeast end of the spillway. This leak was a stream of water approximately 2" in diameter which jetted out of the dam for a distance of approximately 8 feet. Currently this leak has sealed itself and is inactive. None of these leaks are significant at this time; however, when other grouting is done on this structure it would be expedient to seal these leaks.

4. Efflorescent Spots - We tested several of the white efflorescent spots on the downstream face of the dam where leaks had previously occurred and have sealed themselves off. In all of the efflorescent spots which we checked there was sound concrete underneath and no indication of any significant deterioration of the concrete surface.

5. Deteriorated Concrete - As mentioned in the previous reports, there is considerable deterioration of the concrete surface in the third lift from the crest of the spillway. This deterioration begins immediately northeast of the normal spillway crest and extends all the way to the northeast abutment. The spalling reaches a maximum depth of approximately 5". This concrete was apparently of poor quality and has deteriorated due to weathering.

6. Intake Structure - The water intake valve operators appear to be well maintained. The concrete surface of the roof slab has weathered and spalled to a depth of approximately 2".

7. Erosion - There was no visible evidence of erosion anywhere around this dam. Mr. Leroy Early informed me that during the recent floods early this spring, water cascaded over the dam and shot downstream as much as 50'. During this torrential rain, he said that there was erosion of the streambed at the toe of the dam in excess of 15' deep. Broken rocks from the streambed were thrown out of the creek and on to the adjacent banks. Subsequently, the broken rocks from the streambed were pushed back into the stream with front end loaders and leveled into the previous position. In our checking of the plans of the original structure, we find that the maximum depth of concrete here is approximately 5.5' below the top of the concrete toe. Any undercutting underneath the concrete toe of the dam would be significant.

Recommendations:

We make the following recommendations for repair of the Gatewood Dam:

1. Explore the streambed at the toe of the dam to identify the location of existing bedrock and the extent of undercutting of the toe of the dam, if any. Once the location of bedrock is located in this area, then an appropriate concrete apron can be designed and placed in the streambed. We recommend that any apron placed in this area be founded on bedrock.

2. The small leaks in the concrete section should be sealed off by drilling the dam from the top and grouting with a cement grout. Since these leaks are more active during the winter time than warmer months, we would suggest that consideration be given to grouting the dam while temperatures are low. This would allow for identification of more leaks as well as allowing the cracks to be sealed at their maximum size.

3. Resurface the top of the water intake structure slab with a high quality concrete topping bonded with epoxy. The deteriorated concrete should be chipped down to firm material and replaced on a slope such that the surface will drain naturally and will not collect water.

4. Grout the leaks in the abutments with a cement grout. We feel that the leak at the southwest stream edge can be sealed by forcing grout into the outlet. The leak at the northeast abutment may be sealed while grouting the deteriorated concrete outlined in item number 5 by drilling down into the bedrock.

5. Grout the deteriorated concrete lift (3rd lift below spillway @ northeast end) and replace the deteriorated concrete surface with epoxy bonded cast-in-place concrete. The grouting should precede the resurfacing of the downstream face. The maximum repair area appears to be approximately 120' x 5'.

We estimate that the grouting and repair of the concrete surfaces at Gatewood Dam could cost approximately $50,000. A lightly reinforced concrete apron in the streambed 2' thick and with 9000 square feet of surface could cost as much as $50,000.

The cost estimate of repair for both dams should be considered as an order of magnitude cost only and are based on our visual inspection.

Should you decide to proceed with the repairs, we will be happy to prepare the plans and specifications required. We thank you for the opportunity to have been of service to the Town of Pulaski again.

If you have any questions about this report or if we can be of further assistance, please let us know.

Very truly yours,

WILEY & WILSON, INC.

W. B. Nolen

W. B. Nolen, PE

WBN/bc

cc: R. C. Dodl

APPENDIX V

REFERENCES

APPENDIX V

REFERENCES

1. Recommended Guidelines for Safety Inspection of Dams, (Washington, D.C., Department of the Army, Office of the Chief of Engineers).

2. HEC-1 Flood Hydrograph Package, (Hydrologic Engineering Center, U.S. Army Corps of Engineers, January 1973).

3. Design of Small Dams, (U.S. Department of the Interior, Bureau of Reclamation, Second Edition, 1973).

4. "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian," Hydrometeorological Report No. 33, (U.S. Weather Bureau, April 1956).

5. "Rainfall Frequency Atlas of the United States," Technical Paper No. 40, (U.S. Weather Bureau, May 1961).

APPENDIX VI

CONDITIONS

APPENDIX VI

CONDITIONS

This Report is based on a visual inspection of the dam, a review of available engineering data, and a hydrologic analysis performed during a Phase I investigation as set forth in the U.S. Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams and the contract between the U.S. Corps of Engineers and Gilbert Associates, Inc.

The foregoing inspection, review, and analysis are by their nature limited in scope. It is possible that conditions exist which are hazardous, or which might in time develop into safety hazards, that are not detectable by this inspection, review, and analysis. Accordingly, Gilbert Associates, Inc. cannot and does not warrant or represent that conditions which are hazardous, or which may in time develop into safety hazards, do not exist.